Stratolab: The Navy's High-Altitude Balloon Research

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[Pleasantries.] Don Chandler took you to the depths of the ocean. I'm going to take you to the high stratosphere, the edge of space, and tell you about a project that NMRI certainly had something to do with a number of years ago. The title of this paper is "Stratolab V: Triumph and Tragedy."

On the fourth of May 1961, an aluminum cage suspended beneath a 411-foot hydrogen-filled balloon ascended from the deck of the aircraft carrier *USS Antietam*, cruising in the Gulf of Mexico about a 138 miles southeast of New Orleans. In less than 2 hours, the two-man crew had reached the very edge of space. Stratolab V marked a series of firsts in high-altitude flight.

- The 113,500 foot maximum altitude established a new world record for manned balloon flight.
- The 10 million cubic foot balloon was the largest balloon ever used in manned flight.
- The ascent was the first ever made from the flight deck of an aircraft carrier.
- That ascent was the highest made by man in an open gondola.

However, in an instant, the triumph of that mission would turn to tragedy, as one of the crew members drowned in a freak accident during recovery. Moreover, another event occurring almost

simultaneously would totally eclipse the flight of Stratolab and consign it to obscurity.

High-altitude balloon research was nothing new in 1961. Back in 1935, a flight sponsored jointly by the Army Air Corps and the National Geographic Society rose to the then incredible altitude of 72,395 feet, and that record remained unchallenged for nearly two decades. It was felt at the time that this altitude would never be surpassed by balloon, because a rubber balloon expands during ascension into the stratosphere to the point where it finally bursts. However, by the end of World War II, the Navy became interested in the use of plastics, which do not have the same expansion characteristics as rubber.

The Office of Naval Research (ONR) made the first plans for upper atmosphere balloon research for the Navy in 1946. What kind of high-altitude data were they seeking? Near space physics? Nuclear energy, cosmic radiation, and, of course, human physiology. The original project was called Helios, named for the Greek sun god. A contract with the University of Minnesota and General Mills, Inc. called for the construction of plastic balloons and a gondola equipped with a battery of scientific instruments. A sealed cabin was to be supported by 100 of the balloons at an anticipated altitude of 100,000 feet for 10 hours.

Dr. [Gene Picard? Jean Piccard?] and O.C. Windson were among the principals in this project, working along with ONR's commander George Hoover. Their concept was to use a thin plastic material which permitted a reduction in the weight of the balloon

itself to only a fraction of what a rubber balloon would weigh, thereby allowing the plastic cluster of balloons to reach a considerably higher altitude. This ambitious plan was superseded in 1947 by another project called Sky Hook, which involved the use of polyethylene balloons carrying instrument packages to extreme altitudes. Thousands of these balloons were eventually sent into the atmosphere, I should say the stratosphere, for basic research.

In 1952, a new technique developed. Deacon rockets were lifted above 70,000 feet by Sky Hook balloons, and at a fixed altitude a pressure switch was designed to fire the Deacon from an almost vertical position, thereby achieving a much higher altitude than could have been achieved by launching the rocket from a ground level. So successful were these flights that in 1954 there were plans to entrust the lives of men to a thin film of polyethylene plastic. Stratolab came into being in 1955 as a practical, economical method of obtaining fundamental data in the fields of astronomy, astrophysics, and physics of the upper atmosphere.

During the next 6 years, five Stratolab flights were made, four of which used gondolas originally constructed for the original abortive Helios project. Test equipment, including cameras to photograph the formation, growth, and decay of contrails created by jet aircraft, special gamma telescopes of cosmic radiation study, and most importantly a wide variety of aeromedical experiments. Captain Norman Lee Barg, whom some of

you knew and perhaps worked with, had developed a telemetry method for recording in real time a pilot's physiological reactions, heart reactions, and respiratory condition. In 1956, Stratolab I, manned by Lieutenant Commander Malcolm Ross, U.S.N.R., and M. L. Lewis, attained a record altitude of 76,000 feet. [inaudible; other? over?] flights sponsored by ONR shortly began reaching even higher with balloons designed to gather data in the upper atmosphere.

One of the principal elements of this research was to evaluate the effects of stratospheric flight upon man. The first manned Stratolab flight took place on 10 August 1956. The 125,000 cubic foot balloon and fiberglass gondola were launched from Minneapolis and reached an altitude of 40,000 feet.

[First slide]

This is Lieutenant Commander Ross on the lower left and Charles Moore, who took a later Stratolab flight. The goal of this Stratolab flight was to photograph jet vapor contrails and gather other data. Constant physiological data on the pilots was telemetered to a chase plane. Special cold weather clothing protected the pilots to the -60 degrees Fahrenheit temperature they encountered.

Stratolab V had a gondola that was open, but prior to the open gondola--I'll show you a picture of that open gondola in a little bit--prior to the open aluminum cage, the only things

pressurized--well, I should say the capsules that went up previously were sealed like you see this one here--they were either aluminum spheres or fiberglass spheres or a combination of both. What was unique about the Stratolab was the open gondola, as I mentioned.

This shows one of the suits--I believe this was a Mercury suit that was going to be tested in Stratolab V. The only thing pressurized inside Stratolab V would be the suits themselves. The flight would provide the toughest test yet for a new generation of space suits, and that is the mercury type Navy Mark 4 full-pressure suits, which would be operating for the first time in what was considered a near-space environment.

Stratolab V was truly a cooperative Navy effort, sponsored by the Bureau of Medicine and Surgery, Bureau of Naval Weapons, the Office of Naval Research, with technical assistance of the Naval Air Crew Equipment Laboratory, the Aviation Medical Acceleration Lab, and, of course, the Naval Medical Research Institute.

The crew of Stratolab V--Commander Malcolm Ross, again, one of the most experienced of the balloon pilots and Lieutenant Commander Victor A. Prather, Jr., Medical Corps, United States Navy, who was to be the medical observer. Ross, as I said, was a veteran of many balloon flights. For Prather, this would be the first.

The helium-filled balloon was a polyethylene plastic envelope 1,000th of an inch in thickness, and this supported the

gondola, which itself hung from a large parachute, 70 feet in diameter. It was designed to open automatically to bring the gondola down if the balloon failed. The balloon, parachute, gondola, and the trailing antenna made the craft taller than an 80-story building. The balloon itself was needle-shaped at sea level, but took the form of an onion at high altitude with the pressure a mere .09 lbs per square inch.

Windzen Research, Inc. in Minneapolis designed the craft, that is, the balloon and the open gondola, which had adjustable slats, black on one side and aluminized on the other so as either to absorb or to reflect the sun's heat. And I think you can see the slats here. [Picture?] This is the actual open gondola of Stratolab V with pilot and co-pilot. I believe it's Ross on the left and Prather on the right. The slats functioned like Venetian blinds. To warm the gondola, the astronauts simply lowered the Venetian blinds all around the gondola and turned the black side out so as to absorb energy from the sun. To cool themselves, if they needed to, they simply turned the blinds silver side out to reflect the sun.

Before donning their pressure suits, technicians affixed sensors to Ross and Prather. Collodium and rubber cement held the electrodes firmly in place. Such physiological data as EEGs [electroencephalograms], EKGs [electrocardiograms], rectal temperature, face and face plate temperature; axillary, thigh, left foot, and left hand temperatures would be telemetered to the ship. This is Prather, by the way, getting into his suit right

here. Two transmitters, one for each man, were to transmit signals on such functions as respiration, pulse rate, heart beat, and temperature, which were relayed to six separate telemetry receivers, three for each man, located on land, sea, and in the air. This system of redundancy provided protection against malfunctioning of any individual receiver. These data were automatically recorded and transmitted directly to monitoring personnel both aboard the carrier, the *Antietam*, and in tracking aircraft. The medical monitors were Navy physician Captain Paul Pruitt and Dr. Seymour Stein, a civilian, both from the Pacific Missile Range Biosciences Office. Stratolab V contained the most elaborate medical monitoring telemetry network yet employed in a manned flight.

The crew, as I mentioned earlier, was equipped with Mercury type, Navy Mark 4 full-pressure suits modified for this specific flight. The primary oxygen source for the suit was two liquid oxygen converters with a gaseous oxygen walkaround bottle for reserve or emergency. Additionally, each suit backpack contained a bailout gaseous oxygen supply of 1-liter capacity. The main oxygen supply performed four functions:

1. The oxygen first served to ventilate the suit by carrying moisture away from the pilot.
2. The oxygen served as a flushing system to maintain the CO_2 level within safe limits.
3. The oxygen served for breathing purposes.

4. It provided the necessary pressure within the suit at higher altitudes.

The suit was designed to maintain its pressure at approximately 27,000 feet and maintain its 5 psi pressure above that altitude. The gondola was completely nonpressurized, and the only pressurization supplied for the air crew was through operation of the individual suits and supporting equipment. At peak altitude, the pressure would be only--as I mentioned earlier--.09 pounds per square inch, compared with 14.7 at sea level. Without the heavy pressure suits, blood would boil; blood vessels and organs would rupture. In short, the two crewmen would be in an environment virtually equivalent to the vacuum in space.

The Mercury type full-pressure suits had no inherent flotation capability in the water in the absence of complete suit integrity, and that integrity depended on the face plate that had to be closed and sealed. Unfortunately, this feature would later prove fatal for one of the crew members.

Besides obtaining medical data, there were other goals as well. [inaudible] emulsions were to be transported aloft for post-flight analysis to monitor the existence and nature of cosmic radiation. There were also cameras aboard to record Ross and Prather throughout the flight and to photograph the sky for metereological purposes. Another camera would take a series of time lapse photos of the balloon to determine its performance,

and still other cameras were to photograph the sky for use in the study of cloud physics. A Navy 70-mm aircraft reconnaissance camera would determine the capability of operational equipment for very high altitude reconnaissance. This, as you can see, was a multimission mission.

[inaudible] instruments measured pressure, temperature, winds, and water vapor in the atmosphere. Some of these instruments were standard issue; others, experimental. The gondola also provided a test bed for special infrared instruments being developed for satellite use.

The flight plan--the plan was to make an early morning ascent with a planned rate of 800 feet per minute to the anticipated peak altitude of 120,000 feet. After leveling off at that altitude and floating for 1 hour, the pilot would initiate descent at 400 feet per minute to 35,000 feet and 600 feet per minute from 35,000 feet to landing. Elapsed time for the flight was expected to be between 8 and 9 hours. Launch conditions, as they were for most balloon flights, were very stringent. The winds throughout the flight had to ensure a landing within 150 miles of the launch site. The surface visibility at launch had to be greater than 5 miles with a ceiling at launch higher than 1,000 feet. The surface winds in the expected landing area could not exceed 15 knots, and the sea conditions had to ensure a reasonably stable flight deck.

Because of tears to the balloon caused during inflation and a requisite delay in making repairs, Commander Ross considered

aborting the flight even before they took off. However, the tears were minor and easily repaired. But the launch delay, which lasted about an hour, caused Dr. Prather to begin overheating, giving medical monitors serious concern for his condition. But that concern was taken care of, and an hour later the balloon lifted off *Antietam*'s flight deck, approximately 07:07 hours.

The ascent was uneventful--here's the actual ascent from the *Antietam*. [Presumably a picture here] All systems functioned satisfactorily, except for the electrocardiogram telemetry device on Commander Prather, which due to his previous overheating had ceased to record. However, the data loss was not considered integral to the flight. Forty-five minutes after launch at an altitude of 42,000 feet, Ross temporarily lost communications with the ship, but immediately afterward the radio link was restored and the flight continued.

During the latter part of the ascent near peak altitude, a change in the ascent indicated to Ross and the project coordinator back on the *Antietam* that some air had entered the balloon and might complicate the descent. In fact, it would slow the descent rate from altitude to the level of the tropopause and below that level the rate of descent would speed up to a higher than desired speed. However, even with that speeded up rate, the total descent time might exceed the oxygen supply prior to reaching a safe altitude where the balloonists could rely on outside air.

The peak altitude was achieved at 9:47 am. It was recorded at 113,500 feet by mercury manometer and 110,700 feet by beacon. Because of the air in the balloon, early, prolonged valving was necessary during descent above the tropopause, and this had several effects. There was a longer time than planned at near peak altitude; their descent to the tropopause was slower than planned, and the descent through the tropopause was faster than originally planned. This too speedy descent required them to begin jettisoning equipment to slow the rate, and this precluded a landing aboard the carrier. Believe it or not, they had planned somehow to land this balloon on the deck of the carrier. This would have been quite a feat. It would be a water landing.

Commander Ross requested and received permission to open their face plates after passing through the 15,000 foot altitude. Biotelemetry from Prather ended at 40,000 feet, 62 minutes prior to landing; biotelemetry from Ross terminated at 15,000 feet. Because their radio equipment had to be jettisoned to lighten the load, they lost voice communications about 18 minutes prior to the landing at an altitude of about 6,300 feet. However, their skillful managing of throwing out ballast lowered their descent rate just enough to ensure a soft water landing at latitude 28 degrees 11 north, longitude 86 degrees 15 west, approximately 1 mile from the aircraft carrier.

The balloon detached on impact, and the gondola remained upright. The parachute fell into the water as planned, but did not release from the gondola. The crew was unable to activate

the mechanical releases as originally planned. The recovery of the two crewmen seemed to offer nothing particularly unusual. Their gondola bobbed in the water, as I said about a mile from the *Antietam*. The plan was to recover the crew with a motor whale boat as the primary means of pickup; this had been rehearsed. But since three helicopters were hovering above, the plan suddenly changed. The decision was made to make an unrehearsed helicopter recovery.

Both men, needless to say, were physically and psychologically fatigued to an extreme degree, having been through what they'd just been through, but nevertheless they were elated by their success. Neither man had bothered to relower his face plate, and both remained open. When the helo lowered the rescue seat--it was actually a hook, not a seat--Commander Ross, after inviting Lieutenant Commander Prather to go first--Prather declined and Ross then was hoisted above the helo. Now, Ross still had not lowered his face plate. When he grasped the cable, he stepped into the seat contrary to the proper procedure--and as I said, it's been called a seat, but it's not really a seat, it's a hook--and his foot immediately slipped from the seat. Still retaining his grasp on the cable, he pulled it between his legs, slid onto the device, and was hauled aboard without any further problem. And then tragedy struck.

When the seat was lowered for Prather, he stood on a float attached to the side of the gondola. He grabbed the cable, pulled it toward him, and stepped onto the rescue--I'm going to

call it a hook rather than seat--with one foot, the other foot remaining on the float. The hook swung in an outward direction, and his weight pushed the gondola to the rear. He lost his grip on the cable and fell backward into the water from about 3 feet elevation. The crew aboard the helicopter was under the impression that the suit was water-tight, and it would have been had the face plate been lowered. But the plate was open, and Prather immediately began taking in water. By the time the helo returned and dropped a rescue swimmer--and having freed a stuck hoist, which even added to the delay--Prather had drowned.

Notwithstanding this last minute tragedy, what had Stratolab accomplished? Here's a photograph of Commander Ross, who I understand had just been informed of what had happened. He had just been returned to the deck of the *Antietam* and had just been told that his friend and fellow crew member had drowned.

[Picture]

Notwithstanding this last minute tragedy, what had this flight, what had this mission accomplished? Besides achieving a new altitude record for manned balloon flight, Stratolab's instruments had determined that protons associated with solar flare activity on the sun were of such high intensity as to have an ominous import regarding their effects on man in space. The flight, however, had lived up to all expectations save one. A crewman had been tragically lost, and only after the most dangerous portion of the mission had been completed, or so it seemed. Stratolab V had ended on a sad and embarrassing note,

but it had accomplished, as I said, several things.

The discovery of the protons and the extra solar flare activity that had not been anticipated necessitated the development of a system whereby solar flare activity could be predicted and monitored. The mission also validated that telescope astronomy provided a means of obtaining photographs of a quality and resolution heretofore impossible with earth-bound telescopes. Subsequently, an infrared system enabled unprecedented astronomical study--but perhaps the legacy of Stratolab V is unknown for another reason. On the very next day, May the fifth, Stratolab would be totally eclipsed on the front pages of the world's newspapers, as another expedition to the edge of space took place. On that day, May 5, 1961, astronaut Alan Shepard took his historic 15-minute suborbital flight and, to say it again, the rest is history.

[Mrs. Behnke; introduction of Sammy Joseph]